

MICRO-ORGANISMS IN THE AIR OF
PUBLIC BUILDINGS AND
CONVEYANCES,

DUE TO IMPROPER METHODS OF CLEANING.



BY

ELMER W. FIRTH, C.E., A.M.,

FELLOW IN SANITARY ENGINEERING, COLUMBIA UNIVERSITY.



*Submitted in partial fulfilment of the requirements for the
Degree of Doctor of Philosophy in the University
Faculty of Pure Science.*

MICRO-ORGANISMS IN THE AIR OF
PUBLIC BUILDINGS AND
CONVEYANCES,

DUE TO IMPROPER METHODS OF CLEANING.



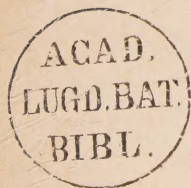
BY

ELMER W. FIRTH, C.E., A.M.,

FELLOW IN SANITARY ENGINEERING, COLUMBIA UNIVERSITY.



*Submitted in partial fulfilment of the requirements for the
Degree of Doctor of Philosophy in the University
Faculty of Pure Science.*



NEW YORK:

1899.



Digitized by the Internet Archive
in 2026

https://archive.org/details/IA41555004_0061

MICRO-ORGANISMS IN THE AIR OF PUBLIC BUILDINGS AND CONVEYANCES, DUE TO IMPROPER METHODS OF CLEANING.*

Numerous investigations have demonstrated the presence of micro-organisms in the air everywhere and under all conditions, except over the open sea (1), on mountain summits, and in the polar regions, but they are found in greatest numbers in the vicinity of large cities, and especially where poor hygienic conditions prevail (2). The occurrence of bacteria in air, however, is only temporary (3, 4), owing to the greater specific gravity of the organisms, or of the dust particles to which they may be attached. They may, furthermore, be regarded as foreign to air, for the reason that this medium does not afford the requisite moisture and organic nutriment; but some species may retain their vitality under such unfavorable conditions for many days or even weeks, as proved by certain experiments on the communication of infectious diseases through the air (5).

Without attempting to establish a standard for the bacterial purity of air, but simply to give a few figures for comparison, it may be stated that from observations made at Montsouris Observatory, averages for several years give as the number of micro-organisms per cubic meter for city air (Paris) 5,400 bacteria and 1,700 moulds (maximum number of bacteria, 21,000 in July, and minimum, 350 in December), and for country air, 290 bacteria and 190 moulds (maximum number of bacteria, 1,000 in July, and minimum, 72 in December).

It may be said of micro-organisms in air as in other media, that if their presence has no greater significance, it at least indicates facility for transportation and conditions suitable for viability, which may be shared as well by pathogenic forms as by the more common harmless species.

With our present limited knowledge of the etiology of the diseases and morbid conditions affecting men and animals, it is impossible to say what relation the so-called non-pathogenic forms bear to these conditions.

Though there is at present a tendency to attribute many diseases directly to the action of bacteria, and especially of certain specific forms, still the importance of other factors must not be underestimated. All other impurities in air may indirectly assist the suspended parasitic organisms in gaining entrance to the

* The bacteriological studies involved in this paper were made in the Laboratories of the Department of Pathology, of the College of Physicians and Surgeons, Columbia University, N. Y.

body; flying dust aiding their transportation and causing irritation of the respiratory passages, and foul gases, acid vapors, and unhealthy meteorological conditions influencing or determining a predisposition to disease.

Canfield (6) has summarized the pathological effects due to the inhalation of dust of animal and vegetable origin without the influence of micro-organisms, and Lageneau (7) concludes that dusty occupations particularly predispose to tuberculosis. On the other hand, Wright (8) and Thompson and Hewlett (9) have found that the majority of the micro-organisms in inspired air are destroyed in the mucus lining of the nose; however, though there exist certain natural means for the prevention of infection, their abuse, as in the constant breathing of dusty air in time reduces the sensibility and activity of the organs performing this function, and disease may follow.

The bacterial contamination of a fluid, either liquid or gaseous, is a case of irregular suspension of impurities rather than a solution containing in equal volumes, equal quantities of the impurity. In a solid medium, as the soil, any contamination is necessarily local and easily detected; in liquid media, such as water, the presence of any particular organism is less readily demonstrated, but its removal may be effected by artificial purification; biological investigations on air are still more difficult, because, unlike water, it is not confined to definite channels or courses in which an impurity can be traced directly to its source; certain prevailing winds (10), however, may tend to give uniformity in the numbers of micro-organisms occurring in any locality.

The detection of pathogenic bacteria in outside air, and their elimination from it, is almost hopeless, and every reasonable precaution should be taken to prevent their access to it. To this end, all infectious material should be immediately destroyed or disinfected, and, next in importance, the maintenance of clean streets will in turn encourage and promote efforts to secure clean buildings and conveyances, which are the units of municipal cleanliness.

It is of course impossible to keep the floors and sittings in buildings, and conveyances free from dust and micro-organisms, because this material is constantly brought in from the streets on the shoes and clothing, but by proper attention to cleaning and the use of suitable furnishings, its elevation into the air by every motion or draught would be less frequent.

It is intended here to show how the bacterial contents of indoor air may be affected by the usual methods of cleaning.

In all investigations calling for biological air analyses, difficulties have been met with, owing to the inaccuracy of methods, and the use of bulky or complicated apparatus. The most important of these methods will be noted before describing the one adopted in this study. They all depend on the detention of the organisms contained in the passing air, either on the moist inner

surface of tubes lined with nutrient media, etc., or in a quantity of some sterile liquid, or in the body of a filter made of fine dry particles. Hesse (10a) used a straight glass tube, wide enough to receive a lining of nutrient gelatine or agar, and the air was drawn through it, but Pawlowsky (11) found that many organisms passed through with the air current, and suggested the use of a tube 3 to 4 cm. in diameter, bent four times at an angle of 45° , each arm being 15 cm. long and similarly lined with gelatine. The air current was very slow, about one litre per hour, and most of the bacteria were caught at the first and third bends in the tube. In these methods the colonies formed in the tubes are counted as in an Esmarch "roll tube."

William (12) employed the same principle in his spiral tube lined with laevulose, but at the end of the test the tube was washed out with 40 c.c of sterile water and eight gelatine plates made, each with 5 c.c of this water. A tube of this form is more expensive than a straight tube, and is more difficult to manipulate, while the possible sources of error from the use of so much sterile water and its distribution to eight plates would make the method very exacting.

Miquel's (12a) apparatus and Kammerer's (12b) modification of it consists essentially of a glass bulb half full of sterile liquid, the bulb terminating below in a small tube, which is bent up on a level with the surface of the liquid; the air is aspirated through it from the top of the bulb.

Straus and Wurtz (13) have devised a special form of apparatus, which consists of a tube terminating below in a closed end of smaller diameter designed to hold 10 c.c. of gelatine; the upper end is fitted with a hollow glass stopper extending down as a fine tube into the gelatine and fitted externally with a cotton plug, when not in use. An aspirator connected to a small branching tube draws the air down through the hollow stopper and it bubbles through the liquid gelatine. A cotton plug is placed in the branch tube to detain any organisms that may escape through the liquid, and is pushed down and washed in the gelatine, before plates are poured or a roll-tube made of the tube itself. As it is very difficult to detach bacteria from cotton in this way, the plug may not only retain those caught by it, but also many in the gelatine with which it comes in contact. The gelatine tends to solidify during the passage of a current of cold air. To prevent the formation of bubbles in the gelatine it is recommended to place a drop of oil on the surface, but this is not always successful. Sterile water may be used in this apparatus and then plated with gelatine after the test.

Petri's sand filter for air analysis is simply a glass tube containing two separate layers of sand, with grains about 1-3 to 1-5 mm. in diameter, confined between pieces of wire cloth. After the test, when this sand is poured out on an ordinary culture dish and covered with gelatine or agar, the colonies which form are

often obscured by the sand grains. To overcome this difficulty to some extent it has been recommended to distribute the sand between several plates, thus securing a wider separation of the grains; this is also accomplished by the use of much larger plates. A form of filter tube has been devised, one end of which is expanded into a large roll tube with ruled surface to facilitate counting; this obviates error due to contamination in plating, but its greater bulk is a disadvantage.

Pasteur, Gautier and others first conceived the idea of using a filtering material, that could subsequently be dissolved. Miquel (14) substituted for the sand a single layer of sodium sulphate, and Frankland (15), and Sedgwick (16) used finely powdered sugar, but the advantage gained by the solubility of these filters is largely offset by the variation they effect in the composition of the media used in plating. Sugar has the further disadvantage of not permitting of perfect sterilization and of dissolving in contact with moist air. Ficker (17) recommends the use of fine particles of glass instead of sand grains on account of their greater transparency; the tabulated results of his experiments show a greater efficiency for the Petri sand filter than for any other method, except his own filter with glass particles, and slightly modified form, which gives a slight increase in the number of colonies found. He marks the importance of completely covering the particles of sand or glass with the nutrient media, in order to permit the growth of colonies from organisms that may be located on their upper surfaces, but this may be difficult because the particles tend to float, or wash up on each other as the media is poured on the plate.

In my experiments the simplest form of sand filter was used. It consists merely of a straight glass tube having a bore 0.5 cm. in diameter, and constricted near one end to support a piece of wire cloth, on which the sand rests. It is about five inches long and contains a depth of two inches of sand with grains about 0.5 mm. in diameter. A cotton plug is put in each end, and it is sterilized for two hours at 150° C. For use out of the laboratory, this small and inexpensive filter tube is much more convenient than any of the special forms of apparatus that have been devised.

After the test, instead of turning the sand out on a culture plate, it was emptied into a tube of liquid gelatine, the cotton plug of the media tube replaced, and after thoroughly washing the sand in the gelatine by rolling the tube between the finger and thumb, a "pour plate" was made, leaving the sand behind in the tube. To avoid contamination from the outside of the filter tube, it was wiped with a towel wet with carbolic acid.

A second tube of liquid gelatine was then poured into the first tube containing the sand, and after washing again, another plate was poured. A third pour plate was made by repeating the process, and on this plate much of the sand was turned out with the

gelatine. In this method glass particles would have no advantage over common sharp sand.

By turning the sand into the tube of gelatine most of the light dust is carried down into the liquid by the descending grains, and some of it may be taken up in the condensation water on the sides of the tube, and subsequently washed in with the gelatine. When dry filter material is poured out on a plate, some of this fine dust may be driven away by slight air draughts, and even by the falling grains, and, moreover, much time is often required to distribute the grains uniformly over the plates, thus permitting long exposure.

The washing of the sand back and forth in the tube tends to break up masses of bacteria that may be attached to particles of dust, thus isolating colonies that might otherwise occur together, interfering with each other's growth and differentiation. No sterile water is required, the sand is washed three times, and the media is not diluted or altered in composition. For washing the sand, gelatine, owing to its greater specific gravity, has an advantage over water in retaining the organisms in suspension until the plate is poured.

A large part of the sand was poured out with the gelatine on the third plate to ascertain whether a film might be formed around the sand grains, inclosing and retaining some of the organisms, or whether the latter might be retained in cavities of irregular grains. It was observed that colonies were seldom associated with sand grains, even after the first washing.

All of the air analyses in this investigation were made by this method with a view to comparing the enumerations in each series of three plates as a basis for a percentage allowance that might be made in lieu of the plating and counting of the third and even the second plate.

Taking the results of 120 analyses, and summing up the total number of colonies, I find that the number occurring on the second plates is 16.8 per cent. of those on the first plates, and the number on the third plates is 3.7 per cent. of those on the first plate; hence if only one plate is poured after washing the sand in liquid gelatine, 20 per cent. of the number of colonies appearing may be added to give the total number of organisms in the filter. I regard this as a liberal allowance for the organisms remaining in the sand after the first washing; when only one plate is made the time saved by omitting the second and third plates will allow for the more careful preparation of the first plate, and result in the detection of a larger percentage of the total organisms than is shown by my first plates.

A few experiments were made to test the efficiency of the sand filters that were used, and the results, tabulated below, show that only 4 per cent. of the organisms pass the filter.

TABLE I. SHOWING THE RESULT OF TESTS OF THE EFFICIENCY OF THE SAND FILTERS USED.

	Plate.	Counted after				Max. No.	
		3 Days.		4 Days.		per 1 cb. m.	
		Bacteria.	Moulds.	Bacteria.	Moulds.	Bacteria.	Moulds.
April 1. One filter was placed above another, and connected by a short piece of rubber tubing. 9 litres air from Bacteriological Class Room, P. & S., during the sweeping. Test filter, I.	I	108	1	118	4		
	I'	15	0	20	0		
	I''	3	0	1	1		
Control filter.		127	1	139	5	15444	555
	II	0	0	3	0		
	II'	1	0	2	0		
	II''	0	0	0	0		
Second test, one-quarter hour after sweeping. Test filter.		1	0	5	0		
	III	22	0	30	0		
	III'	2	0	4	0		
	III''	2	0	2	0		
Control filter.		26	0	36	0	4000	0
	IV	0	0	3	0		
	IV'	0	0	1	0		
	IV''	0	0	0	0		
		0	0	4	0		
A dusty cloth was shaken near the filter.	I	.....		350	10		
	I'	.....		liq.			
		.....		350	10	38888	1110
Control filter.	II	.....		8	3		
	II'	.....		1	0		
		.....		9	3		

A small hand glass was used in counting the colonies, the covered Petri dish being held firmly under an elastic band, which was slipped around the ruled counting plate. All the colonies and moulds were counted, including those at the edge of the dishes, which may be due to contamination through loose covers. If this source of error were the same for all plates the colonies at the edge might be ignored, with the result that of the total number of organisms in the sand, a smaller percentage would appear on the second and third plates. It is evident that the liability of contamination in making plate three, is almost as great as the possibility of isolating any more of the original organisms in the sand; hence no greater accuracy is to be attained by making a fourth plate.

The means ordinarily adopted for the inspiration of air through test filters are by water displacement, by cylinder air pumps, and by water aspiration pumps. The latter are not portable, and the others, at best, are inconvenient. Ficker (17) used a balloon or bag, 20 cm. long and 10.5 cm. in diameter at its widest part. One hundred strokes were required to aspirate 50 litres of air, and a rate of two to four litres per minute was adopted in some of his experiments. The aspiration should not be accomplished too slowly for the reason that it is often desirable to make an analysis rapidly before the conditions change, as, for example, when a draught from an open door in a building or conveyance is demonstrating the need of more perfect floor cleaning.

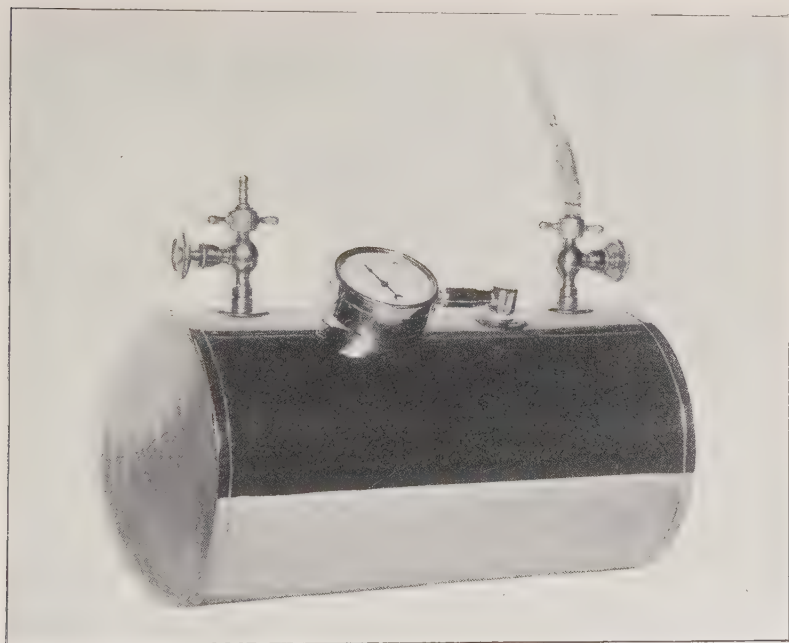


FIG. I.—Aspiration Cylinder, used for taking samples of air for bacteriological analysis. The small sand filter is attached.

In this investigation an apparatus devised by Dr. Prudden was used for aspirating for examination, measured volumes of air in public places. It consists of a metallic cylinder 15 inches long and 7 inches in diameter, furnished with a vacuum gauge and two stop-cocks. This is fitted into a leather bag, with openings to permit of easy operation, and the observation of the gauge. After exhausting the cylinder by means of a small foot-

pump, the sand filter is connected to it by a piece of rubber tubing, the stop-cock opened, and the air passed through into the cylinder, leaving the dust and organisms in the filter. The continuous filtration pressure maintained in this way presumably has an advantage over the spasmodic air draughts caused by the strokes of a pump, the latter having greater power to force impurities through the sand layer. The apparatus, while in operation, can be carried anywhere without attracting more than ordinary attention. A further advantage of this exhausted cylinder is that, while a sample is being taken, there is no disturbance of the surrounding air, which must occur with any other method, and the importance of this is appreciated in making tests on the



FIG. II.—The Aspiration Cylinder in its bag, ready for use.

settlement of dust and organisms, such as are here described in connection with the cleaning of school rooms.

Stern (3) in his experiments on the effect of ventilation on the micro-organisms suspended in air, concludes that in quiet air, settlement is usually complete after one and a half hours, while with the common ventilation allowance of one to three changes or air per hour no material acceleration of air purifica-

tion takes place; but a rapid and complete elimination of germs from dwelling-rooms is obtained by a strong draught.

It would appear then, that our large buildings, as ordinarily ventilated, act as great settling basins, retaining most of the dust and micro-organisms carried in by the entering air or brought in on the clothing. Moreover, in the cleaning of these buildings certain air currents produced in some systems of ventilation may interfere with the settlement of dust after sweeping and thus keep it in suspension, to be inhaled with the air.

Dust-free air in buildings and conveyances is to be secured only by complete removal of all dirt and dust from surfaces which may be disturbed during occupation. Haldane (18) as early as 1887, came to the conclusion that micro-organisms in the air of an occupied room come from the room itself rather than from the breath, skin or clothing of persons present; expired air has since, repeatedly been proved to be sterile (19) (20), but that clothing contributes largely to the contamination of air in such places needs no stronger proof than the common observation of the soiled steps of an elevated station being swept by a woman's skirts. The greatest evil, however, is the stirring up of accumulated dust and dirt from the floors, and the only remedy is in regular washing with a brush or wet cloth.

The following tests were made by means of displacement, measuring ten-litre samples by siphoning 10 litres of water between bottles of about three gallons capacity. At the end of each test it was necessary simply to reverse the position of the bottles and start the siphon again. Six minutes were required for the completion of each test. That there is no leakage is shown by the fact that the siphon can be stopped by simply sealing the end of the filter tube with the finger, even after the flow acquires full momentum; hence the ten litres of air which pass into the upper bottle must all go in through the sand filter. See Fig. III and Tables 2 and 3.

A brief outline of some of my observations as to the methods of cleaning adopted in buildings and conveyances in the vicinity of New York may serve to explain the frequent occurrence of excessive numbers of micro-organisms in the air.

In the Court House in Brooklyn, which is ventilated by a plenum system, one of the fans in the cellar, at the time of my visit, was drawing air over a pile of dirt and rubbish about two feet deep. A very cleanly appearance is maintained in the halls of this building by washing every night, and by the employment of wooden cuspidors about one foot square, containing sawdust; these boxes being large and flat, are not easily upset. All the rooms, including the court rooms, the floors of which are carpeted, are swept and dusted by about thirty women every morning until 9 o'clock, and the courts open at 10 o'clock; sufficient time therefore is not allowed for the settlement of dust before the rooms are occupied, especially as the ventilation system is in constant operation after 5 A. M.



FIG. III.—Apparatus used for aspirating samples of air by water displacement.

TABLE 2. SHOWING THE EFFECT OF THE SETTLEMENT OF DUST IN A CLOSED ROOM.

	Plate.	Counted after				Height above floor, in feet.	Max. No. per 1 cb. m.	
		3 Days.		6 Days.			Bacteria.	Moulds.
March 13. 10 litre samples. Experiment room, 18' x 20' x 8'. One-half litre of dirty saw-dust from floor of a ferry-house was scattered over the floor of the room and allowed to dry for four days. In heated ferry-houses it dries quickly, and the organisms may be raised into the air before many succumb to drying. Dust stirred up by walking about and distributed with a fan. Three tests simultaneously at different levels. Dust stirred up again as above, after twenty minutes. After fifteen minutes' settlement. March 14, next morning, after settlement over night. Windows all opened, and dust stirred up by walking about the room.	I	9	13	12	23			
	I'	0	1	0	2			
	I''	0	0	0	1			
		9	14	12	26	2'	1200	2600
	II	8	2	12	8			
	II'	2	1	2	3			
	II''	1	0	1	0			
		11	3	15	11	5'	1500	1100
	III	5	1	16	7			
	III'	3	1	3	8			
	III''	1	0	1	1			
		9	2	20	16	7'	2000	1600
	IV	6	3	18	11			
	IV'	0	1	3	2			
	IV''	1	0	1	0			
		7	4	22	13	2'	2200	1300
	V	14	4	14	3			
	V'	1	1	1	3			
	V''	1	1	1	1			
		16	6	16	7	5'	1600	700
	VI	7	4	13	7			
	VI'	0	1	0	1			
	VI''	0	0	0	0			
		7	5	13	8	7'	1300	800
	VII	0	1	0	2	2'	0	200
	VIII	1	2	3	3	5'	300	300
	IX	3	0	7	3	7'	700	300
		0	0	0	0	2'	0	0
	X	0	0	0	0	2'	0	0
	XI	4	1	4	3	5'	400	300
	XII	0	0	3	0	7'	300	0
		3	0	11	0	2'	1100	0
	XIII	3	0	11	0	2'	1100	0
	XIV	4	0	5	3	5'	500	300
	XV	1	1	3	2	7'	300	200

TABLE 3. SHOWING THE EFFECT OF THE SETTLEMENT OF DUST IN A
CLOSED ROOM (SECOND SERIES).

	Plate.	Counted after 3 Days.		Height above floor, in feet.	Max. No. per 1 cb. m.	
		Bacteria.	Moulds.		Bacteria.	Moulds.
April 4. Quiet air. Experiment room not disturbed for two days; dry saw-dust still on floor, no ventilation. 10 litres samples, taken at elevations of two and seven feet, by water displacement, and 9 litres samples at five feet with the cylinder. Immediately after sweeping with dry broom; no ventilation; the air very dusty. Tested as before, one hour after sweeping; the air appeared to be quite free from dust.	I	3	1			
	I'	1	0			
	I''	1	0			
		5	1	2'	500	100
	II	4	4			
	II'	2	0			
	II''	2	0			
		8	4	7'	800	400
	III	129	31			
	III'	10	4			
	III''	3	1			
		142	36	2'	14200	3600
	IV	143	20			
	IV'	12	4			
	IV''	2	0			
		157	24	5'	17444	1666
	V	110	23			
	V'	15	3			
	V''	4	0			
		129	26	7'	12900	2600
	VI	19	14			
	VI'	4	1			
	VI''	1	1			
		24	16	2'	2400	1600
	VII	14	7			
	VII'	2	1			
	VII''	2	0			
		18	8	5'	2000	888
	VIII	12	9			
	VIII'	5	2			
	VIII''	4	1			
		21	12	7'	2100	1200

These results show that dry sweeping may increase the number of micro-organisms suspended in the air, 15 to 30 times, as from 600 to 18,000 per cubic meter, and also that in very quiet air a settlement of over 80% of these organisms may take place in an hour.

In the Hall of Records and in the Municipal Building, where several hundred men are employed, ventilation is left to chance save what may be gained by the large central opening, allowing air communication between floors. The cleaning is done in a similar manner, with one redeeming feature, however, that a greater portion of bare floors permits of washing twice a week; the halls and stairs are washed every morning.

In the City Hall, Brooklyn, the ventilation is still poorer, and the vitiation of the air in one of the largely attended court rooms is always very perceptible. The sawdust cuspidors in this building are very much in evidence, especially in the upper corridor, where there are fifteen in a space about fifty feet square. There can be no objection to this if the sawdust is not disturbed, and if it is ultimately properly disposed of, for it has greater effect in maintaining clean floors than twice as many signs prohibiting expectoration. The floor sweepings and waste papers in all these buildings are carried to the cellar, dumped on the floor, the papers sorted out and sold or rarely burned, and the dirt thrown in with the ashes. The dirty sawdust from the cuspidors is also turned into the ash-cans and all find their way to the public dumping grounds in the poorer sections of Brooklyn.

In the New York Post Office the main floor is washed with a hose once a week and the stairways are washed morning and night, but the sweeping and dusting of all rooms, including the carpeted court rooms, is done in the morning from 5 o'clock until the courts open. The cleaning in the Criminal Court Building, N. Y., is not begun until 6 A. M., but with a force of about fifty men and women it is quickly accomplished. Water in which a soap powder is dissolved, is sprinkled with a watering can on the floors of the halls, and on the stairs, and then mops are used to wash and dry them. Waste papers and sweepings are placed together in cans at the edge of the sidewalk, where Italians are allowed to sort out the papers and scatter the dust, leaving little to be removed by the street cleaning carts.

Greater care and intelligence is now being displayed in the cleaning of many large office buildings. The halls, stairs and elevators are washed usually once a day, and the sweeping in most cases is done at night; in some of these buildings a man is employed in wet weather to keep the white tiling on the main floor clean and dry by constant mopping. At the same time careless or thoughtless mistakes are made which tend to spoil the results that would otherwise be attained. In one of the handsomest and cleanest office buildings in New York the hemp mats used in the vestibule are dried in the engine room, carried to the roof in the elevators, and the dirt beaten out to be blown back into their own windows or those of the adjoining buildings. The common use of feather dusters in public buildings is well known to janitors to be an insult to proper cleanliness; but the practice is easy compared with the use of damp cloths, although

the whole building finally has to be cleared of the thick deposits of dust that has been driven into the air by the duster, and settled on every surface high out of reach.

TABLE 4. SHOWING THE NUMBER OF MICRO-ORGANISMS IN THE AIR OF SOME LARGE BUILDINGS. SAMPLES TAKEN WITH EXHAUSTED CYLINDER.

	Plate.	Counted after		Max. No.	
		4 Days.		per 1 cb. m.	
		Bacteria.	Moulds.	Bacteria.	Moulds.
April 21. Postal Telegraph Building, main floor. 9 litres. White tile floor is kept quite clean; taken during the stir of business hours.	I	61	3		
	I'	9	0		
Kings County Court House. 9 litres taken at 10 a. m., in main hallway, while people were passing back and forth.	II	70 106	3 3	7777 11777	333 333
	II'	.....	liq.		
Criminal Court Building, ground floor, April 27, 10 a. m., 9 litres.	V	56	5		
	V'	10	1		
		66	6	7333	666

In some large assembly rooms that are not occupied oftener than once a week, such as the large rooms of churches, much dust is easily disposed of by sweeping early in the week and using a feather duster on Saturday with all windows open on opposite sides of the room, causing a strong draught to pass through, but this practice is obviously wrong in buildings that are occupied almost continuously as hospitals, schools and office buildings, especially where the rooms have windows on one side only.

In winter it is attended by serious loss of heat, and it cannot be adopted at all theatres since they are characterized by their lack of windows.

The following table gives the results of analyses of air in the large room of a church, during the operation of dusting with a feather duster, while all the windows on three sides were open, and again after twelve hours settlement. Seven-litre samples were taken. It will be seen on comparison with the school experiments that the number of organisms here is small; this may be due to the greater dilution of suspended dust in the larger room where the disturbing agent is the same, or to the more rapid purification of the air by a strong draught blowing across the room between the windows on opposite sides. The greater number of organisms in the air of schools may also be accounted for by their more continuous occupation. The samples were taken in various parts of the church room to determine whether the dust was traveling in certain air currents, but the results do not

TABLE 5. SHOWING THE NUMBER OF MICRO-ORGANISMS IN THE AIR OF A
LARGE CHURCH ROOM, DURING DUSTING AND AFTER SETTLEMENT.

	Sample No.	While Dusting.				After 12 Hours' Settlement.			
				No. per cb. m.				No. per cb. m.	
		Bacteria.	Moulds.	Bacteria.	Moulds.	Bacteria.	Moulds.	Bacteria.	Moulds.
Main floor, rear.	1 1'	13 3	6 0			.... ....	.... ....		
Main floor, middle.	2 2'	16 17 0	6 1 0	2285	857	 7 0	 2 0		
Main floor, front.	3 3'	17 6 2	1 0 4	2428	142	7 6 0	2 0 0	1000	285
Front gallery.	4 4'	8 12 2	4 2 0	1142	571	6 7 2	0 1 0	857	0
Rear gallery.	5 5'	14 10 0	2 2 1	2000	285	9 5 0	1 0 0	1285	142
West wing, rear gallery.	6 6'	10 12 8	3 4 6	1428	428	5	0	714	0
East wing, rear gallery.	7 7'	20 12 2	10 2 3	2857	1428	.... .... ....	.... .... ....		
Under rear gallery.	8 8'	14 12 6	5 3 7	2000	714	 4 0	 0 0		
Thirty feet above floor, on organ in front gallery.	9 9'	18 8 2	10 1 0	2571	1428	4 7 3	0 2 0	571	0
		10	1	1428	142	10	2	1428	284

indicate this; on the contrary, the organisms appear to be quite uniformly distributed.

The cleaning in public schools receives too little attention; usually it is left entirely to the janitor, who is as little inclined to employ help to be paid from his own salary as he is to do all the work himself. The class rooms are swept with a dry broom every afternoon, and the dusting is done in the morning before

the school opens. Where twenty to thirty rooms, with their seats and desks, have to be dusted by two men before 9 o'clock the process must be rapid, and it is usually accomplished by passing up and down between the rows of desks with a feather duster in each hand and brushing the dust into the air. On Saturday the sweeping is done a little more thoroughly, but water is seldom if ever applied, except in the annual washing in the summer vacation. As a result the cracks between the floor-boards become filled with dust, which is stirred up at least twice a day during the physical culture, which each class is obliged to take. This exercise begins with marching in single file around the room and back and forth between seats, after which the scholars are instructed to take "long and deep breaths" of the dusty air. At these times the windows are often thrown open, but as they are generally located on only one side of the room, no material reduction of the suspended micro-organisms is accomplished, as is shown by the following experiments.

Below are given the results of experiments on the suspension of micro-organisms in the air of school-rooms before and after dusting, as it is generally done.

The school selected was built in 1897, and represents the latest ideas in school construction. Two ventilators in each room are located in the floor and are connected to a stack heated below by a small furnace. Fresh air is forced in at a point in the wall about six feet above the floor. Three rooms were used; in one all ventilation was stopped; in another the ordinary ventilation was employed, and in the third the windows were opened from top and bottom, in addition to the ventilation. They were swept in the afternoon, and these tests were made on the following morning, when dusting was done with feather dusters, according to the usual practice. A sample was taken in each room before dusting, immediately after dusting and after the intervals of 15, 30, 45 and 90 minutes. See Table 6.

TABLE 6. SHOWING HOW AIR CURRENTS FROM VENTILATION AND FROM OPEN WINDOWS MAY INTERFERE WITH THE SETTLEMENT OF SUSPENDED MICRO-ORGANISMS, AFTER DUSTING. SCHOOL EXPERIMENTS; 7-LITRE SAMPLES TAKEN WITH EXHAUSTED CYLINDER. PLATES EXAMINED AFTER FIVE DAYS.

	Sample No.	No Ventilation.			Sample No.	Ventilation.			Sample No.	Windows Open.		
		Bacteria.	Moulds.	Total organisms per cb. m.		Bacteria.	Moulds.	Total organisms per cb. m.		Bacteria.	Moulds.	Total organisms per cb. m.
April 15.												
Before dusting.	1	17	8		2	37	7		3	16	4	
	1'	4	0		2'	5	2		3'	6	1	
After dusting.		21	8	4142		42	9	7285		22	5	3857
	4	265	29		5	65	5		12	36	2	
	4'	13	4		5'	35	3		12'	12	0	
15 min. after dusting.		278	33	44428		100	8	15428		48	2	7142
	6	....	liq.		7	56	4		13	44	3	
	6'	21	3		7'	14	2		13'	6	0	
30 min. after dusting.						70	6	10857		50	3	7571
	8	25	10		9	36	5		15	63	10	
	8'	7	3		9'	10	2		15'	18	1	
45 min. after dusting.		32	13	6428		46	7	7571		81	11	13142
	10	31	3		11	38	3		17	106	4	
	10'	4	1		11'	6	0		17'	45	0	
1½ hr. after dusting.		35	4	5571		44	3	7000		151	4	22142
	14	15	2		16	11	4		18	68	0	
	14'	8	3		16'	8	0		18'	9	1	
		23	5	4000		19	4	3285		77	1	11142

The results are represented graphically in Fig. IV. by the curves drawn with the time of settlement as abscissa, and the total number of organisms in the seven-litre samples as ordinates. It will be seen that the most rapid settlement takes place in quiet air, as shown by the fall from 311 to 45 micro-organisms in 30 minutes; the opening of windows when located on one side only, as in this case, causes an irregular distribution of the organisms and delays settlement. The second curve represents what takes place when ordinary ventilation is employed during the dusting. There is no means of cutting off the ventilating shaft from the rooms in this building, except by covering the openings, as was done in these experiments; the ventilation is continuous, being strongest when the stack is heated and fresh air is being forced into the

rooms. In a closed room the dust stirred up with a feather duster of course returns again to the same surfaces, so that nothing is gained; with ventilation some of the dust is eliminated, though settlement is slower.

It may be recommended then to arrange the system of ventilation so that it may be cut off during the dusting; to remove the dust with a damp cloth, and then start the ventilation again after an interval of half an hour or more.

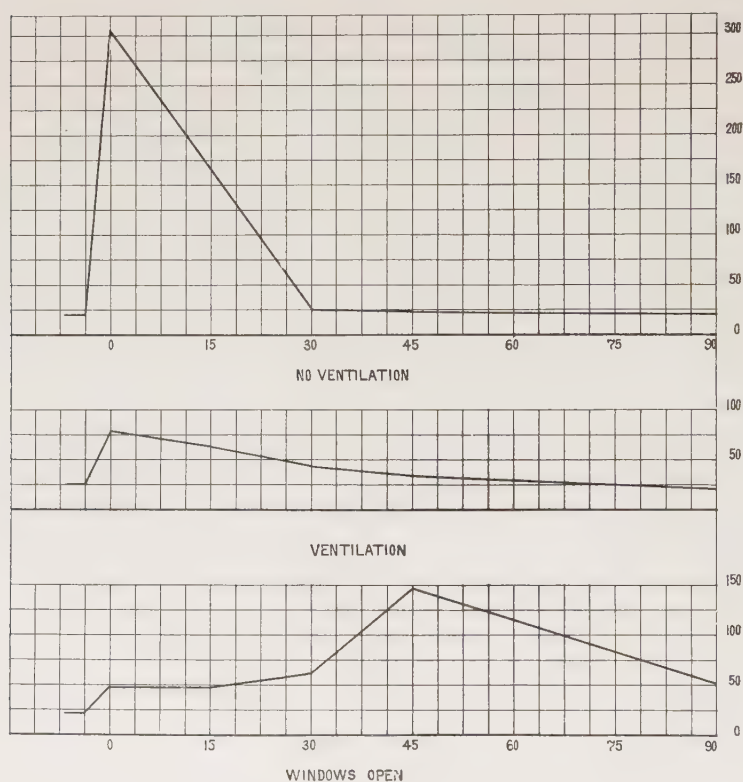


FIG. IV. Diagram showing how air currents from ventilation and from open windows, may interfere with the settlement of suspended micro-organisms, after dusting.

The time of settlement given in minutes, horizontally, and the number of organisms scaled off on vertical lines.

The above experiment was repeated a week later, with the following results: The explanation of the first set of curves applies equally well to those plotted from this table.

TABLE 7. SHOWING HOW AIR CURRENTS FROM VENTILATION AND FROM OPEN WINDOWS MAY INTERFERE WITH THE SETTLEMENT OF SUSPENDED MICRO-ORGANISMS, AFTER DUSTING. SCHOOL EXPERIMENTS; 7-LITRE SAMPLES TAKEN WITH EXHAUSTED CYLINDER. PLATES EXAMINED AFTER FIVE DAYS.

	Sample No.	No Ventilation.			Sample No.	Ventilation.			Sample No.	Windows Open.		
		Bacteria.	Moulds.	Total organisms per cb. m.		Bacteria.	Moulds.	Total organisms per cb. m.		Bacteria.	Moulds.	Total organisms per cb. m.
April 22.												
Before dusting.	1 1'	 19	liq. 2		2 2'	18 12	1 1		3 3'	60 cont	3 ami	9000 nated
After dusting.	4 4'	290 36	15 0		5 5'	30 140 12	2 4 0	4571	11 11'	159 15	6 0	
15 min. after dusting.	6 6'	326 41 1	15 2 1	48714	7 7'	152 102	4 4 liq.	22285	14 14'	174 168 17	6 20 0	25714
30 min. after dusting.	8 8'	42 51 ...	3 3 liq.	6428	9 9'	80 11	9 2		17 17'	185 190 7	20 0 2	29285
45 min. after dusting.	10 10'	16 cont	5 ami	nated	12 12'	91 25	11 liq. 4	14571	20 20'	197 110 6	2 0 0	28428
1 hr. after dusting.	13 13'	15 1	0 0		15 15'	34 8	3 0		23 23'	116 116 16	0 1 0	16571
1 1/4 hr. after dusting.	16 16'	16 22 2	0 4 0	2285	18 18'	42 30 6	3 1 0	6428	25 25'	122 105 21	1 4 0	17571
1 1/2 hr. after dusting.	19 19'	24 20 9	4 8 2	4000	21 21'	36 27 2	1 1 0	5285	26 26'	126 68 10	4 1 0	18571
2 hrs. after dusting.	22 22'	29 11 3	10 0 0	5571	24 24'	29 16 3	1 0 1	4285	27 27'	78 68 8	1 4 0	11285
3 hrs. after dusting.	28 28'	14 10 1	0 4 0	2000	19	1		2857		76	4	11428
	11	4		2142								

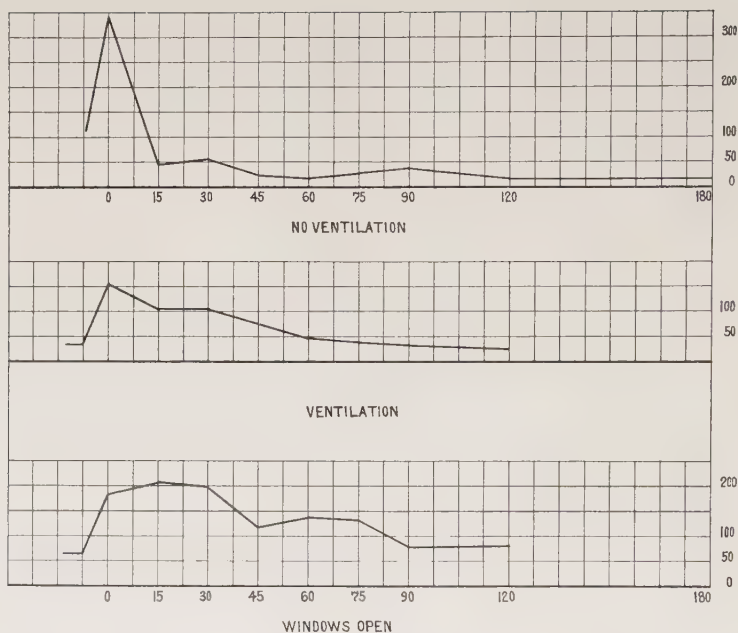


FIG. V. Diagram plotted from Table 7, showing how air currents from ventilation and from open windows, may interfere with the settlement of suspended micro-organisms, after dusting.

The time of settlement given in minutes, horizontally, and the number of organisms scaled off on vertical lines.

In many factories and workshops cleanliness receives only secondary consideration, except where dust and dirt are known to have a damaging effect on the product manufactured. At one brass-polishing establishment where dirty windows and poor light make it necessary for workmen to hold the metal close to the eye in order to examine the surface, I was told by an employee that three out of ten of the men employed had died of consumption within a period of about a year. The extensive trade in old rags and waste paper affords opportunity for communicating disease, and these materials are frequently handled in places adjoining or even within the living rooms of the classes that deal in them. Ulrik (21), in a rag-sorting room, found from 2,000,000 to 4,000,000 organisms per cubic metre of air.

Dusty occupations, and the so-called sweat-shops, where whole families sleep, eat and conduct business in one or two small rooms, are in this country regulated by laws too general to be effective.

The large lobbies or vestibules of the big department stores and of theaters, churches and other buildings frequented by numbers of people, retain most of the dirt from foot-wear and prevent much soiling of the interior. Where these lobby floors are tiled and rubber mats used, the latter can be removed and washed, and the floor quickly cleaned. But in some theatres the floors of these spaces are furnished with a thick padding, which becomes thoroughly charged with dust. On dismissal, when the whole assembly leaves in a body, this dust is forced up into the air as from a bellows, and is kept in suspension by the motion of the people until all have left the building.

The cleaning of dwellings under ordinary circumstances is not a difficult sanitary problem, though it may be interesting to note the order of the Conseil de Salubrité of Paris in 1888 (22) permitting the brushing and beating of carpets only in closed rooms; the dust deposited on the floor to be afterward washed up with a strong disinfectant solution. In cases of zymotic disease, this rule would be none too stringent, even after disinfection by the most approved methods.

The habitations of the poorer classes should be considered a subject of greatest importance in every large city, as on their condition depends to a large extent the health of the whole community. Building laws regulate the arrangement and construction of tenements, but after completion insufficient attention is given to their proper maintenance in a clean condition. In Europe much has been done towards improving the condition of the dwellings of the laboring classes; in London (23) not less than half a dozen companies have been formed for this purpose. In their improved buildings the employment of exterior stairways prevents direct communication between apartments, thus eliminating one great danger of tenement life, the transmission of disease from family to family, through the air. Attempts have been made to introduce a similar improvement in this country (24), but it is not easy to definitely show the greater healthfulness of these buildings, because of the difficulty in obtaining unbiased reports on their vital statistics.

The cleaning of the ferry-houses, slips and boats on all the New York and Brooklyn ferries is conducted under the same system or rather lack of system. Sweeping with a straw broom after a sprinkling of damp sawdust, is done at all hours of the day in both wet and dry weather, and the dust stirred up is inhaled by large numbers of daily passengers. In wet weather sawdust is thrown on the floors of the ferry-houses for the purpose of keeping them dry, and much of it is carried on the shoes into the cabins of the boat, where it dries; it is then pulverized under foot and wafted into the air by the motion of the passengers.

On one occasion I was observing the floor of the women's cabin covered with this fine material in the morning after a day

and night of rain, when suddenly the cabin door was opened and the draught cleared the floor for a distance of a dozen feet, sending a cloud of dust back through the boat.

A sweeper with a dry broom is usually seen passing here and there among the passengers in the ferry-houses, cleaning wherever a clear floor space presents itself; it might better be left uncleaned than to be swept at such times.

I have frequently seen a feather duster used in these cabins, even in the narrow passageway which leads past the side-wheel box, as people were passing through.

Expectoration on the floors of ferry-houses is very common, and here, above all other places, is this habit dangerous, for here people in great numbers, from all quarters, are massed together for several minutes at a time, keeping the air and the dust from the floor in constant motion. There is much evidence to prove that the common mode of communicating tuberculosis is by the inhalation of dust containing dried tuberculous sputum. (25.)

In the women's cabin of these boats very few violations of the health ordinance on this point are now observed, which is evidence of measurable decrease in the habit, brought about by the recent agitation of the subject. Many attempts have been made to stop expectoration in public, by rules so stringent that officers themselves could not hope to enforce them. In Atlanta, Ga., such a law is at present being rigidly enforced, and arrests are made for spitting in the streets. However, the habit can best be overcome by gradual steps, and the use of cuspidors wherever they can be conveniently placed will teach men to look for them or use a handkerchief.

There is not a public cuspidor on any of the ferries from New York to Brooklyn, either in the ferry-houses or on the boats, and yet in the men's cabin, where smoking is allowed, a copy of Section 194 of the Sanitary code is posted, forbidding spitting on the floor.

Where the use of tobacco is permitted in buildings and conveyances, expectoration in public places is encouraged, and this within sight of such a prohibitory ordinance, moreover, tends to cultivate lawlessness. There is a tendency for men to spit at the base of supporting columns, which is noticeable in ferry-houses, on the Brooklyn Bridge platforms and elsewhere. In most of the ferry-houses the crusty deposit of dirt which accumulates here is never cleaned up because the dry broom has no effect on it. Cuspidors could be conveniently used at these points and be protected by a railing fastened to the column.

On account of the similarity of construction and maintenance of all the ferries the following tests may be taken as representative of the condition of the air in each.

It will be noticed that the number of colonies appearing after five days' growth is in some cases smaller than was recorded on

the third day; this is due to the fact that after five or six days the rapid growth of moulds or the liquefaction of the gelatine often conceals some of the colonies that have been counted on previous days; hence the maximum count is usually obtained on the third or fourth day.

TABLE 8. SHOWING THE NUMBER OF MICRO-ORGANISMS IN THE AIR OF THE HOUSES AND BOATS OF A NEW YORK AND BROOKLYN FERRY.

	Plate.	Counted after						Max. No.	
		3 Days.		4 Days.		5 Days.		per 1 cb. m.	
		Bacteria.	Moulds.	Bacteria.	Moulds.	Bacteria.	Moulds.	Bacteria.	Moulds.
March 20, 6 p. m. Ferry-house, New York side; near door, as people were passing onto the boat; 4½ litres.	I	57	1	73	2	77	3	21332	888
	I'	13	0	14	0	17	1		
	I''	2	0	2	0	2	0		
March 27. Sample as above, 4½ litres.	I	72	1	89	2	96	4	31111	2888
	I'	122	6	120	7	104	8		
	I''	12	0	17	3	12	3		
March 27. Men's cabin, as men were passing out; very smoky; 4½ litres.	I	134	6	140	10	121	13	16000	3332
	II	37	10	45	12	22	....		
	II''	13	1	20	2	14	2		
March 30. Ferry-house, New York Side. Man sweeping here and there with a dry straw broom.	I	52	12	72	15	40		27666	1100
	I'	....	....	237	3	230	4		
	I''	....	....	12	1	19	1		
March 31. Women's cabin, 10 a. m. Dry weather; sample taken while walking through the cabin.	I			250	4	250	5	14222	444
	I'	103	2	110	3	....	....		
	I''	11	0	15	0	....	....		
April 14. Hamilton Ferry-house, 6 p. m. 9 litres.	I	2	0	3	0			20777	2777
	I'	116	2	128	0	....	....		
	I''	151	15	....	....	159	22		
		16	0			28	3		
		167	15			187	25		

The use of cocoa mats in the cars of the elevated roads in Manhattan establishes a condition that is prejudicial, if not perilous, to the health of passengers. These mats rapidly absorb all the liquid filth which is deposited on them, and part with it again after it has dried on the fibres. A deposit of dirt is generally to be seen on the floor under these mats, having been shaken from them as they were thrown into place, and this, together with clouds of light dust which rises into the air when they are dis-

turbed, gives sufficient proof of inadequate cleaning, no matter how honest the endeavors in this direction may be. These cars are cleaned in the train yards once a day. The mats are lifted up and shaken in the cars, and then set out on the platforms until the floors have been swept with a dry broom; the mats are then replaced on the floor and sprinkled with a solution of thymol for the purpose of disinfecting them. As diluted for this purpose the solution contains 1 per cent. of thymol, and as it is applied rapidly with a sprinkling can, it is safe to say that not one-fourth of the superficial area of the mats is wetted. Without speculating on the efficacy of such pretended disinfection, the following simple tests will show the results actually obtained. By placing in flasks containing 50 c.c. of sterile water, some of the thread-like fibres of one of these mats, and plating with gelatine a measured quantity of the water after standing twenty-four hours, I have estimated that on a fibre one and a half inches long, from the outer surface, there were in this instance between three and four million bacteria, and on an inner fibre of the same length there were nearly two million; another test indicated 900,000 and 180,000 respectively. This shows also to what degree these mats may become saturated with dirt.

Spitting in these cars is much more common than it is in conveyances where floors are kept bare, simply because the deposit disappears so nicely. Hidden filth is the cause of more evil than is visible filth, for the reason that it is not as easily avoided or as likely to be cleaned up; as has been shown, these cocoa mats under the present method of treatment retain much dirt, and though perhaps appearing clean, they are at every foot-step giving off to the air dust rich in micro-organisms, some of which may be pathogenic. In cars having the seats arranged along the sides facing each other, a sense of decency restrains many passengers from soiling the floors, as they will do when not observed, as in the less conspicuous cross seats; moreover, the floors can be more easily and are usually more thoroughly cleaned than in cars furnished with cross seats. (See exper. on cars.) The cleaning of the cable cars on the Brooklyn Bridge also is inadequate. When these cars were operated by the city, each train was changed for cleaning every twelve hours, whereas it has since happened that trains have occasionally been run continuously for four or five days. At times the meshes of the mats in these cars have been filled with dirt.

Some non-absorbent material should be used in place of these mats, or in dry weather the floor may be kept bare. If rubber mats or iron or wooden floor "racks" were used, their cleaning could be easily effected by thorough washing, since the dirt they retain is superficial only. In the new cars of the Brooklyn elevated roads mats have been abolished and wooden strips are employed, running lengthwise in the cars and fastened perman-

ently to the floors. This is a step in advance, as it permits the use of soap and water, and does away with accumulations of dirt, such as are favored by the use of cocoa mats.

TABLE 9. SHOWING THE NUMBER OF MICRO-ORGANISMS IN ELEVATED ROAD CARS.

	Plate.	Counted after						Max. No.	
		3 Days.		4 Days.		5 Days.		per 1 cb. m.	
		Bacteria.	Moulds.	Bacteria.	Moulds.	Bacteria.	Moulds.	Bacteria.	Moulds.
March 27. Ninth Ave. Elevated train; last car, middle seat; 7 litres.	III	18	1	27	1	29	2		
	III'	3	0	3	0	2	0		
	III''	1	0	1	0	1	0		
April 1, 6 p. m. Sixth Ave. Elevated train; last car; 9 litres.		22	1	31	1	32	2	4571	285
	I	58	4	.....	.....	.....	.....		
	I'	9	1	.....	.....	.....	.....		
	I''	4	0	.....	.....	.....	.....		
April 15. Ninth Ave., 2 p. m.; 9 litres.		71	5	.....	.....	.....	.....	7888	555
	I	146	1	.....	.....	203	6		
	I'	20	0	.....	.....	26	2		
April 13. Fifth Ave., Brooklyn. Wooden floor- strips; cross seats; 4½ litres.		166	1	.....	.....	229	8	25444	777
	I	.....	.....	80	3	93	5		
	I'	.....	.....	7	2	15	3		
Another train on same line; first car, all side seats; 4½ litres; floor strips.		.....	.....	87	5	108	8	24000	1776
	II	.....	.....	43	5	45	10		
	II'	.....	.....	5	1	5	1		
April 20. Fifth Ave., Brooklyn; first car; wooden floor-strips; all cross seats. 4½ litres.		.....	.....	48	6	50	11	11110	2444
	I	.....	.....	.....	.....	78	2		
	I'	.....	.....	.....	.....	6	6		
Another train on same line, crossing bridge; first car; floor strips; all side seats. 4½ litres.		.....	.....	.....	.....	84	8	18666	1776
	II	.....	.....	.....	.....	43	0		
	II'	.....	.....	.....	.....	4	1		
April 21. Sixth Ave. Elevated train; first car; comparatively new mats.		.....	.....	.....	.....	47	1	10444	222
	I	.....	.....	66	4	.....	.....		
	I'	.....	.....	14	0	.....	.....		
	.....	.....	.....	80	4	.....	.....	8888	444

The air in surface cars is much the same as that of the streets, owing to their small capacity and the frequency of the air changes, as both front and rear doors are opened at almost every street corner; this is more especially true in summer, when open cars are used. In winter, when snow covers the streets, the micro-

organisms in the air of heated closed cars may be more abundant than in the outside air. Wooden floor racks are commonly used, and these are to be preferred to strips nailed to the floors, for the reason that the necessary washing of the latter may cause dampness in the cars while in use. A number of clean dry floor racks can always be kept on hand to replace the dirty ones removed for cleaning, and the change made quickly and without delay.

Section 185 of the Sanitary code providing for the daily cleaning of all cars operated in New York City is but rarely observed by the railroad companies.

Perhaps the dirtiest cars used in the city are those of the horse car lines, of which the Chambers Street line is an example. The external aspect of most of these cars is uniformly repulsive, especially after wet days, when the mud spattered up by the horses has dried on the ends and sides of the cars; this, however, can more safely be left to the tolerance of the public than can the dirty floors, windows and seats. The substitution of electric and cable power for horses and steam power on surface and elevated roads is an important step toward securing greater municipal cleanliness.

Since the air in surface cars is largely the same as the outside air, a few experiments may be admissible here, to show how the purity of this air depends on the weather and the condition of the streets.

On Feb. 18 in a dense fog seven samples of ten litres each were taken on a roof about 40 feet above ground; a gentle breeze was blowing clouds of fog about the apparatus, and each filter was moist inside from the passage of the damp air; the ground was partially covered with snow. Three plates were made from each of these filters, and all remained sterile except two which had one or two moulds near the edge, that were evidently accidental contaminations.

TABLE 10. SHOWING THE NUMBER OF MICRO-ORGANISMS IN THE OPEN AIR IN WET AND DRY WEATHER.

	Plate.	Counted after						Max. No.	
		3 Days.		4 Days.		5 Days.		per 1 cb. m.	
		Bacteria.	Moulds.	Bacteria.	Moulds.	Bacteria.	Moulds.	Bacteria.	Moulds.
February 23. 10 litre samples of air taken from roof 40 ft. above ground. Clear day; South-west wind; no rain for four days; ground wet with melting snow.	I	0	0	0	0	1	0	100	0
	I'	0	0	0	0	0	0		
	II	0	0	0	0	1	0		
	II'	0	0	0	0	0	0		
	III	0	1	0	1	2	2	200	200
	III'	0	0	4	0	3	1		
	III''	0	0	1	0	1	1		
	IV	0	0	5	0	4	2	500	200
	V	0	0	2	0	3	0	300	0
	VI	1	0	1	1	2	5	200	500
	VII	0	0	2	0	2	2	200	200
	VII'	0	0	3	0	9	1	900	100
	I	68	0	88	0			10200	0
	I'	4	0	10	0	.....	.....		
	I''	1	0	3	0	.....	.....		
	II	73	0	102	0	.....	.....		
April 7. 10 litres taken as above; South-west wind, quite strong; clear day; no rain for several days; streets dry and dusty.	II'	138	1	164	1			18800	100
	II''	18	0	21	0	.....	.....		
	II'''	3	0	3	0	.....	.....		
	III	159	1	188	1	.....	.....		
	III'	79	0	106	1			12000	0
	III''	7	0	8	0	.....	.....		
	III'''	4	0	6	0	.....	.....		
	90	90	0	120	0	.....	.....		

In all my observations I have noticed a tendency to maintain simply that degree of cleanliness which will satisfy the classes concerned, regardless of any definite standard. This is very evident to any one who in riding through the poorer sections of the city will compare the condition of the cars with those operated in other localities; ferries also seem to minister to the demands rather than to the needs of their passengers.

The systematic cleaning of public buildings and conveyances is a sanitary measure deserving the most intelligent supervision, and the sanitary regulations governing it should provide especially for the protection of those classes which are least capable of taking care of themselves.

SUMMARY.—Having made specific recommendations for the correction of the various errors in cleaning as each was considered, it is here necessary only to give a summary of the principles on which the problem is based.

In the first place no attempt should be made to conceal dust and dirt, as is the aim in the use of certain absorbent floor materials now commonly employed.

Disinfection should not be substituted for the removal of accumulated dirt.

Simple construction of the interior of conveyances facilitates cleaning.

Non-absorbent flooring should be used in public places, and this means the abolition of carpets from theatres, churches, and especially from court rooms, and of fibre mats in cars and boats; linoleum and rubber mats might be substituted. The application of damp sawdust on bare floors and pieces of wet paper on carpets is effective in retaining some of the dust raised in sweeping.

The suspension of dust and organisms in the air after sweeping and dusting depends on the specific gravity of the material as well as on the condition of rest or motion of the air itself. In the quiet air of a closed room the settlement may be quite complete after a period of from 15 to 30 minutes, while in ventilated rooms the air may not reach its normal bacterial purity for two hours or more after cleaning.

Strong air currents from open doors and windows may keep the organisms in suspension for an indefinite length of time, unless the draught can pass directly across the room between openings on opposite sides.

Hence time must be allowed for settlement, and sweeping or dusting should not be done in a place of assembly for several hours previous to occupancy, depending on the possibility of air disturbance by ventilation or otherwise.

Dry sweeping and dusting should never be done in the presence of numbers of people, as is now the practice in some conveyances.

Inasmuch as ordinary ventilation fails to remove much of the dust or many of the organisms that gain entrance, all buildings act as settling basins for the solid impurities of the air that passes through them, and the absolute removal of this material, together with the dust which settles after sweeping, is best accomplished by the use of damp cloths; frequent washing or mopping of the floors is also essential to proper cleanliness in public places. Such removal of dust in moist condition at any time is quite unobjectionable, since few organisms thus gain access to the air, but as dampness must be avoided, the substitution of stone or tile for wooden flooring should precede the adoption of such a practice.

Finally, the material accumulated in cleaning should be so disposed of that it will not be merely a nuisance transferred to another place, but one absolutely suppressed.

BIBLIOGRAPHY.

1. Bacteriologisches Untersuch. der Luft über dem Meere.
Zeit. für Hyg. Bd. XVII. s. 185, 1894, Fischer.
2. Mikrobiologische Luft-analyse.
Centlb. f. Bacter. w. Paras., Bd. XVI. s. 635 Pereira.
3. Über den Einfluss der Ventilation auf in der Luft suspendirte
Microorganismen.
Zeit. für Hyg. Bd. VII. s. 70 R. Stern.
4. Über Luftinfection.
Zeit. für Hyg. Bd. XXV. s. 179, 1897, Flügge.
5. Die Übertragung der Diphtheria durch die Luft.
Zeit. für Hyg. Bd. XXV. s. 439 Germano.
6. Inhalation of Dust and Pulmonary Disease.
Amer. Jour. of the Med. Science, Vol. 104, p. 686. Can-
field.
7. Revue de la Tuberculose, 1893, p. 88. Lagneau.
8. Nasal Bacteria in Health.
New York Med. Jour., Vol. 50, p. 92. Wright.
9. The Fate of Micro-organism in Inspired Air.
Lancet, Jan. 11, 1896, p. 86. Thompson and Hewlett.
10. Rev. Baumgarten's Jahrsb. Bd. V. s. 553. Roster.
- 10a. Über quantitative Bestimmung der in der Luft enthalt-
enen mikroorganismen.
Mitt. aus der Kaiserlichen Gesundheitsamte. Bd. II.
s. 182. Hesse.
11. Ein neuer Apparat zur quantitativer Bestimmung der Bak-
terien der Luft.
Centlb. f. Med. Wiss. 1885, No. 33 s. 585. Pawlowsky.
12. Versuche über die Verbreitung der Cholera bacillen durch
Luftströme.
Zeit. für Hyg., Bd. XV. s. 170. William.
- 12a. Les organismes vivants de l'atmosphère. Miquel.
- 12b. Archiv für Exper. Path. u. Pharm. Bd. XXI. s. 318.
Kammerer and Giacomi.
13. Traité de Microbiologie, 1898, p. 409. Duclaux.
14. De l'analyse microscopique de l'air au moyen de filtres
solubles.
Annal. de microgr., 1889, t. I., No. 4, p. 146. Miguel.
15. Methode der bacteriologischen Luftuntersuchung.
Zeit. f. Hyg., Bd. III. s. 287. Frankland.

16. A New Method for the Biological Examination of Air.
Proc. of the Society of Arts, Boston, 1888. Sedgwick and Tucker.
17. Zur Methodik der bacteriologischen Luftuntersuchung.
Zeit. f. Hyg., Bd. XXII. s. 33, 1896. Ficker.
18. Micro-organisms in Schools and Lecture Rooms.
Rev. Med. News, Dec. 24, 1887, p. 751. Haldane.
19. La Semaine Médicale, 1887, No. 49, p. 493. Strauss and Dubreuil.
20. Ann. de l' Inst. Pasteur, 1888, t. 2, p. 181. Strauss.
21. Rev. Baumgarten's Jahrsb., Bd. VI. s. 563, 1890, Ulrik.
22. Dust from Carpet Cleaning.
Rev. Med. News, May 5, 1888, p. 503.
23. Maisons ouvrières. Traité de l' Hygiene Publique. Palmberg.
24. Amer. Pub. Health Assn. Rept., Vol. XV., p. 69. A. T. White.
25. Die Verbreitung der Tuberkelbacillen ausserhalb des Körpers.
Zeit. Für Hyg. Bd. V. s. 191, 1888. Cornet.



